
Space Weather Technical Forecast

Issued on Sunday, 31 March 2024 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further M-flares likely from AR3615 (R1-R2 Blackouts) in the short term, with slight chance of X-flares (R3 Blackouts) but risk decreases through Day 2 (01 Apr). Chance of G1 Minor Geomagnetic storm intervals later in the period given expected HSS influence.

Analysis of Space Weather Activity over past 24 hour

Solar Activity: Activity has been Moderate with a long duration M-flare peaking at M9.4 at 30/2116 UTC from AR3615. There are four active regions currently on the visible disc. AR3615 remains the largest and most complex region, although much of the group has now rotated beyond the western limb with only the far trailing portion still visible. This makes accurate assessment of the region impossible, with a previous classification retained. All other regions remain generally small and or simple, with much of the visible disk devoid of activity.

There have been a number of CMEs observed in coronagraph imagery over the past 24 hours, none of which were analysed to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind measured by ACE/DSCOVR at L1 started the period at slow-ambient levels (around 330 km/s), before increasing from around 30/1300 UTC with the onset of a likely incoming high speed stream from CH15/+. Wind speeds showed a steeper increase from 30/1729 UTC becoming Slightly Elevated at 30/1847 UTC and are currently at Elevated levels around 510 km/s. Density near average with a brief window of above average early in the period, peaking at 18ppcc at 30/1205 UTC. Interplanetary Magnetic Field, Bt, initially on an increasing trend, rising to a peak of 14nT at 30/2039 UTC before values plateaued at generally weak levels. The north-south component, Bz, fluctuated moderately between +8nT/-9nT but largely remained positive. The phi angle has remained mostly positive (away from the Sun). Geomagnetic activity was Quiet to Active (Kp 1-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) remained mostly at background and well below the S1/Minor Radiation Storm level. High energy electron flux (greater than 2MeV) observed at GOES16 has been background with a diurnal peak at moderate levels. The associated 24-hour fluence remained below Active, with a value of 1.20e7 integrated pfu at 31/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity at first, with a slight chance remaining of an isolated X-flare from AR3615 as it continues to rotate across the southwest limb. This region is expected to depart the disc later Day 1 (31 Mar) with flare risks reducing significantly. However, any notable Strong flares may remain observable into Days 2-3 (01-02 Apr). Activity is then expected to be Low.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs currently forecast during the period. Solar winds are expected to remain at Elevated to Slightly Elevated

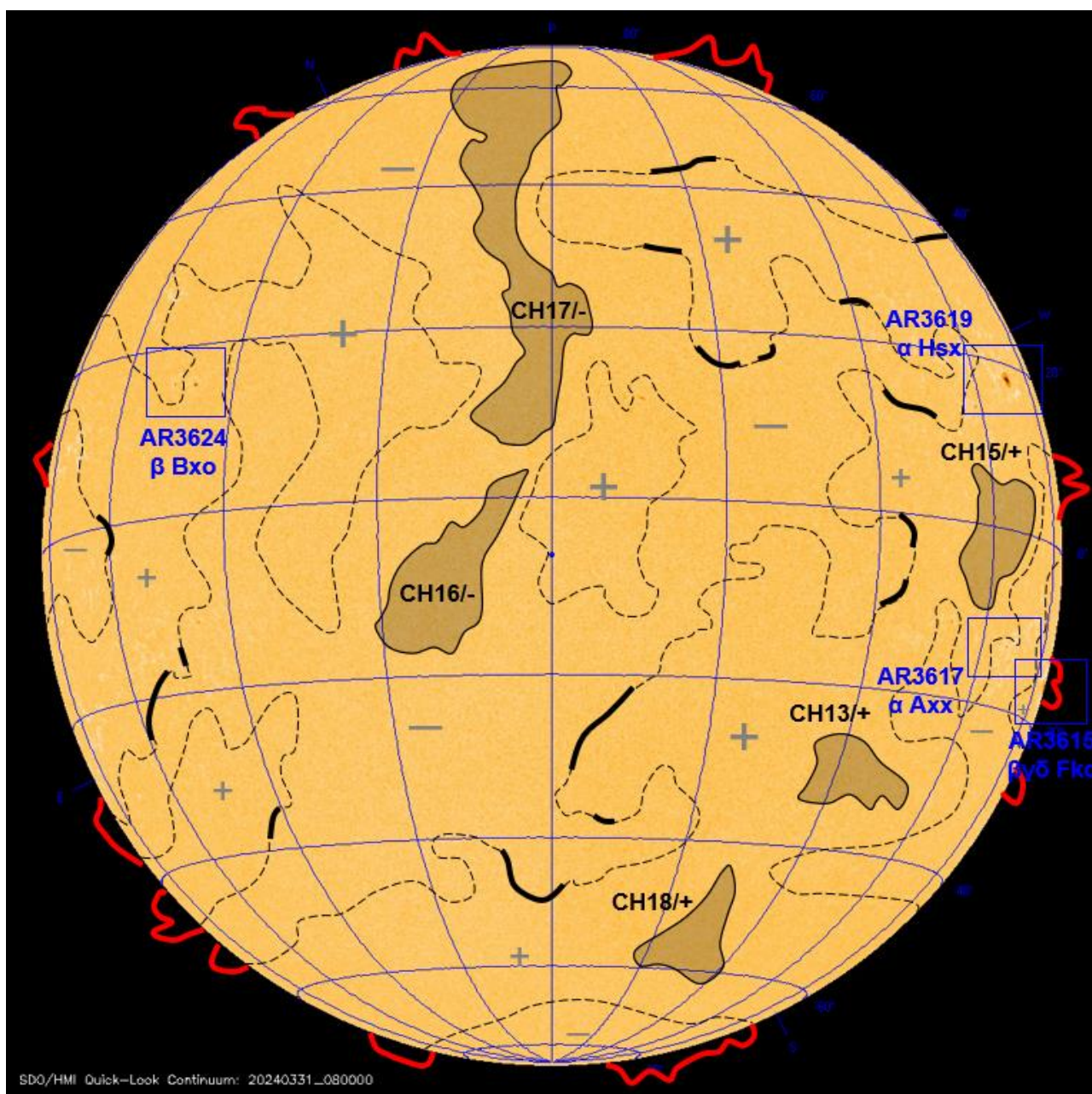
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levels Days 1-2 (31 Mar-01 Apr) given ongoing coronal hole influence from CH15/+ and CH13/+, perhaps peaking at Elevated levels before easing into early Day 3 (02 Apr). The expected arrival of further fast winds associated with CH16/- and CH17/- may see winds return to Elevated levels later Day 3 or into Day 4 (03 Apr) with an increased chance of geomagnetic response.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp 2-3) but with a chance of Active intervals Day 1 (31 Mar). Activity expected to increase from later Day 3 (02 Apr) into Day 4 (03 Apr), with Unsettled to Active conditions expected and an increased chance of G1 Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18, is expected to be near background levels, but with a slight chance of enhancement above the S1 level given any strong flares from AR3615 until Day 3 (02 Apr). High energy electrons are likely to continue at Low to Moderate levels, with only a slight chance of reaching High. The associated 24 hour fluence may exhibit a slight increasing trend initially but is expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 31/0800UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

At present, there are no Earth-directed CMEs expected during the forecast period.

Solar wind speeds are currently at Elevated levels, around 500 km/s following the likely onset of a HSS associated with CH15/+. HSS influence likely persisting into Day 2 (01 Apr), with an additional contribution possible from a HSS from CH13/+. These are small, non-recurrent features and are generally not favored for significant geomagnetic response at this time of year due to their positive polarity. MOSWOC Enlil is too slow with the onset of the HSS, although wind speeds are considered reasonable. Wind speeds may ease somewhat later Day 2 (01 Apr) into Day 3 (02 Apr). Further HSS enhancement from the larger coronal holes CH16/- and CH17/- current near centre disk may arrive at Earth by the end of the period as currently signaled in ENLIL output. These features appear larger and stronger than on the last rotation, and their negative polarity may produce a more appreciable geomagnetic response. Speeds of 450-550 km/s thought likely from later Day 3 into Day 4 (02-03 Apr).

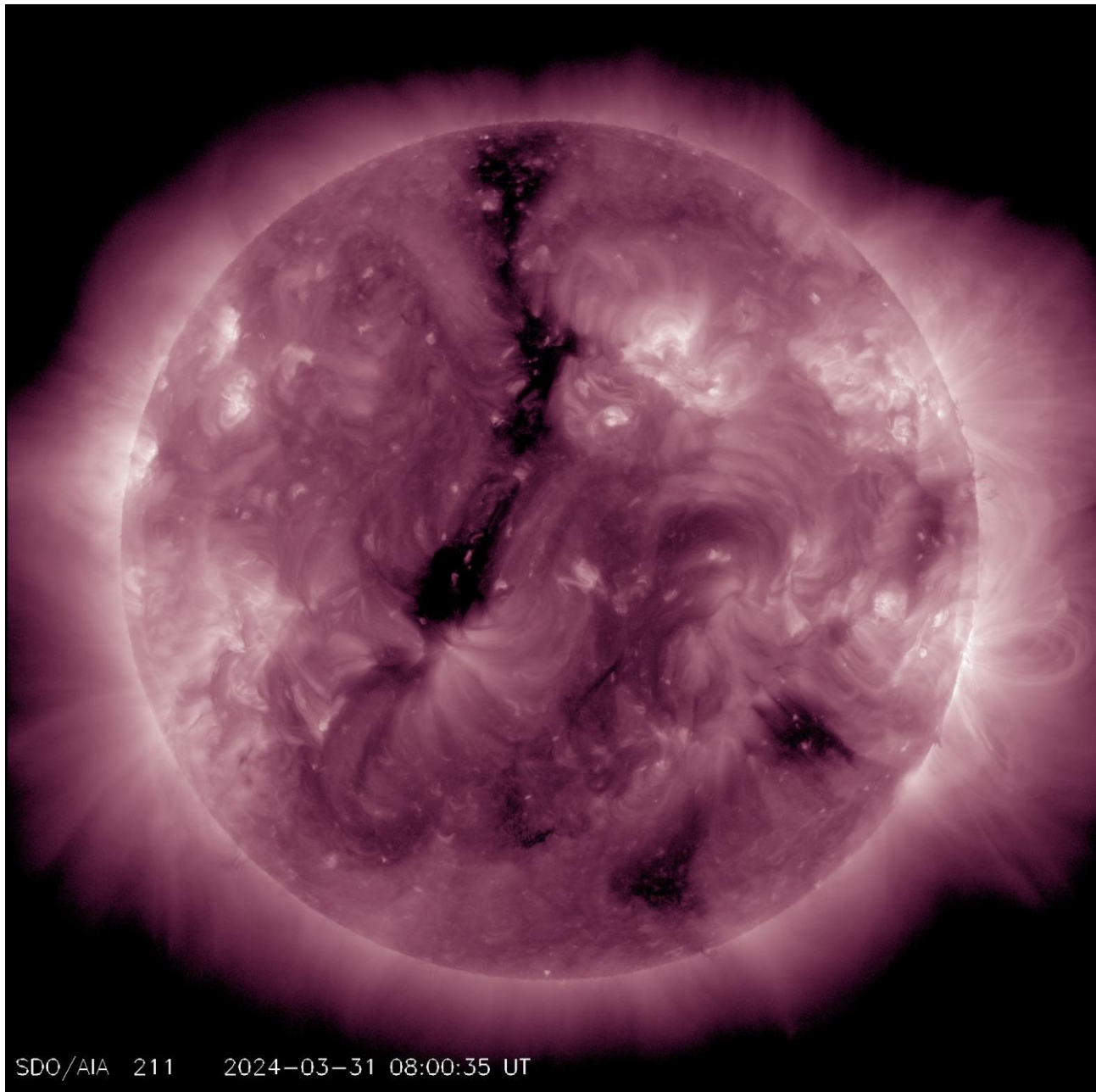
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	25	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil

Figure 2: Recent SDO/AIA 211 imagery showing multiple coronal holes visible on the current disk. Including the large CH16/- and CH17/- in the central/northern disk.



Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected Day 1 (31 Mar), with a chance of further M-class flare activity and a slight chance of an isolated X-flare from AR3615 as it continues to rotate across the southwest limb. As the region rotates away over the limb, the risk gradually reduces, with generally the risk of any large flares being observable easing later Day 2 (01 Apr). Activity is then expected to be Low.

AR3615 (Fkc/Beta-Gamma-Delta) dominates the flare forecast, likely remaining a very large and relatively complex sunspot group. Due to the restricted viewing angle of the group as it approaches the western limb the previous analysis has been retained and further analysis restricted. The other spots are all small and or simple regions, unlikely to be sources of notable flare activity. All but one of these regions lie close to the western limb.

Far-sided seismic imagery suggests that new or returning regions may emerge onto the solar disc later in the period with flare probabilities increasing somewhat into Day 4 (03 Apr) to allow for the possible emergence of these, or other regions that may develop on the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	20	5	15
Very Active	R3 to R5 X Class	No	15	5	1	1

Figure 3: Recent SDO/AIA 94 imagery showing continued X-ray flux associated with AR3615 as it rotates over the southwest limb



Solar Radiation Storms - (High Energy Protons):

High energy proton flux observed by GOES-18 is now at background levels. Further large flares from the departing AR3615, especially more intense or longer duration ones, could still be eruptive and proton rich. The associated risk of proton events is maintained until the region has rotated fully beyond the west limb, declining by Day 3 (02 Apr).

There is a slight chance of reaching the S1/Minor Radiation Storm threshold Days 1-2 (31 Mar-01 Apr), given any further significant flaring from this region.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	20	20	5	1
Very Active	$\geq \text{S3}$ *	No	5	5	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. ($\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux as observed by GOES-16 at GEO, has remained at generally background levels, but with a diurnal peak towards Moderate. Ongoing coronal holes influence from CH15/+ and CH13/+ is expected to generally restrict flux levels at GEO, reducing the risk of prolonged High flux levels initially. Later in the period, the likely connection to coronal holes CH16/- and CH17/- also expected to suppress flux levels, with any persistent increase to High levels not expected until after forecast period.

The associated 24 hour electron fluence is expected to remain below the Active level, although a slight rising trend is possible during Days 1 and 2 (31 Mar-01 Apr). A further suppression of fluence levels is then expected from later Day 3 or Day 4 (02-03 Apr) due to the expected arrival of, and connection to, fast winds from coronal holes CH16/- and CH17/-. Although fluence levels are currently somewhat above REFM forecast levels, REFM is still considered to be giving good guidance for the overall trend.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	5	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output

